



LHC at CERN - Geneva, Switzerland



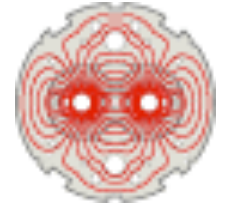
Fermilab - Batavia, Illinois

Remote Operations for LHC and CMS

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Overview



- Remote operations in high energy physics (HEP)
- What is LHC@FNAL?
- Remote operations for LHC
- Remote operations for CMS
- Summary



HEP Remote Operations



With the growth of large international collaborations in HEP, the need to participate in daily operations from remote locations has increased.

Remote monitoring of experiments is nothing new. This has been done for more than 10 years.

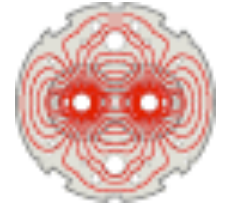
Remote operations is the next step, to enable collaborators to participate in operations from anywhere in the world.

The goals are to have:

- secure access to data, devices, logbooks, monitoring information, etc.;
- safeguards, so actions do not jeopardize or interfere with operations;
- collaborative tools for effective remote participation in shift activities;
- remote shifts to streamline operations.



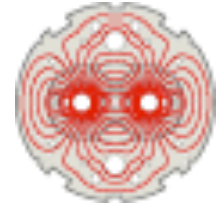
What is LHC@FNAL?



- **A Place**
 - That provides access to information in a manner that is similar to what is available in LHC and CMS control rooms at CERN
 - Where members of the LHC community can participate remotely in LHC and CMS activities
- **A Communications Conduit**
 - Between CERN and members of the LHC community located in North America
- **An Outreach tool**
 - Visitors will be able to see current LHC and CMS activities
 - Visitors will be able to see how future international projects in high-energy physics can benefit from active participation in projects at remote locations.



How did the Concept for LHC@FNAL Evolve?



Fermilab

- has contributed to CMS detector construction,
- hosts the LHC Physics Center (LPC) for US-CMS,
- is a Tier-1 grid computing center for CMS,
- has built LHC machine components,
- is part of the LHC Accelerator Research Program (LARP), and
- is involved in software development for the LHC controls system through a collaboration agreement with CERN called LHC@FNAL Software (LAFS).

The LPC had always planned for remote data quality monitoring of CMS during operations. Could we expand this role to include remote shifts?

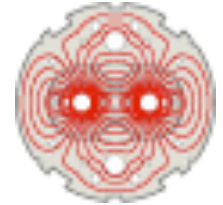
LARP was interested in providing support for US-built components, training people before going to CERN, and remote participation in LHC studies.

We saw an opportunity for US accelerator scientists and engineers to work together with detector experts to contribute their combined expertise to LHC & CMS commissioning.

The idea of joint remote operations center at FNAL emerged (LHC@FNAL).



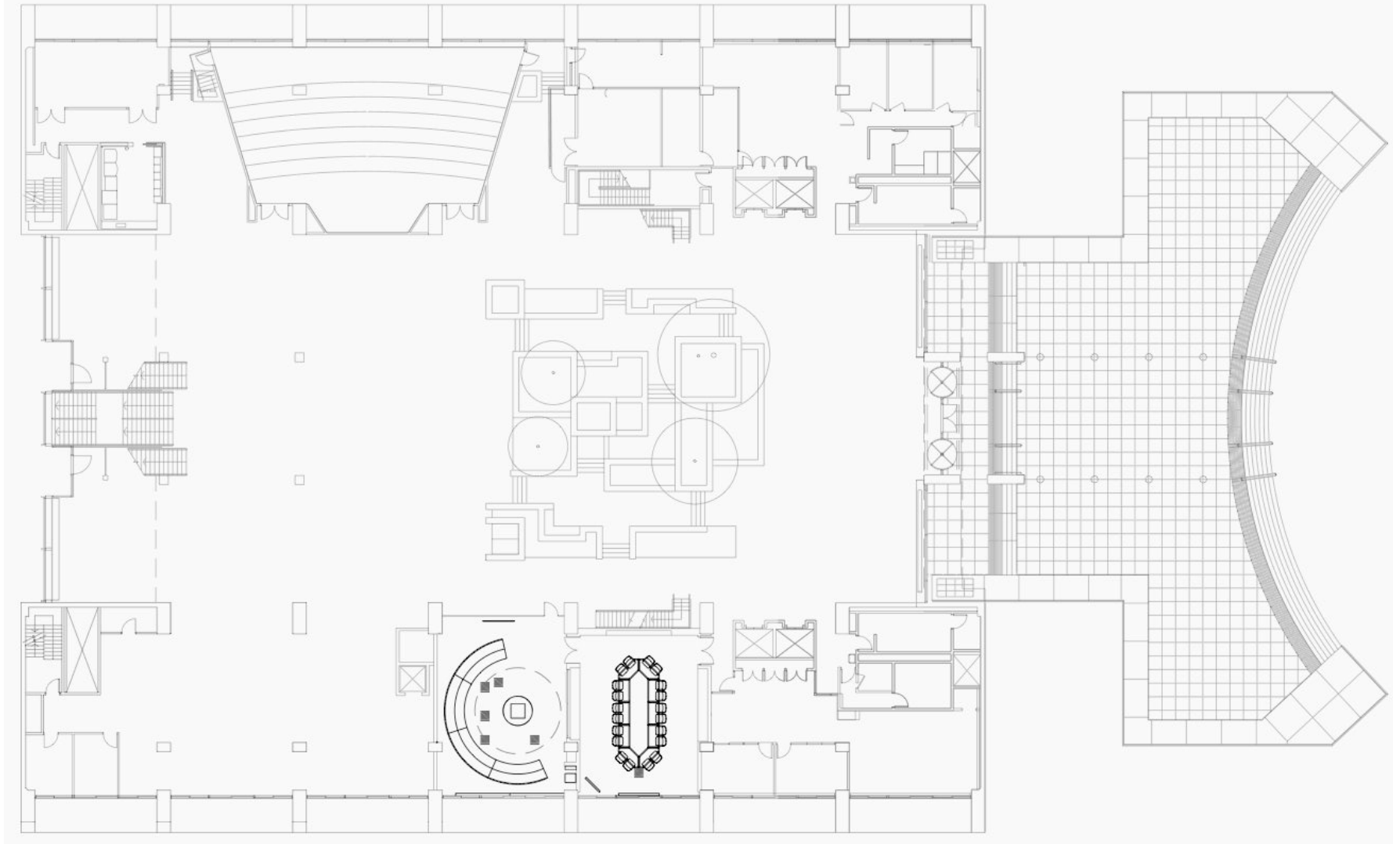
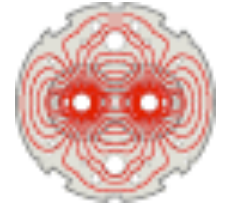
Development of LHC@FNAL



- We formed a task force with members from all Fermilab divisions, university groups, CMS, LARP, and LHC. The advisory board had an even broader base.
- The LHC@FNAL task force developed a plan with input from many sources including CMS, LHC, CDF, D0, MINOS, MiniBoone and Fusion Energy Sciences.
- We worked with CMS and US-CMS management, as well as members of LARP and LHC machine groups at all steps in the process.
- We prepared a requirements document for LHC@FNAL, which was reviewed in 2005.
- We prepared a Work Breakdown Structure (WBS), and received funding for Phase 1 of LHC@FNAL from the Fermilab Director in 2006.
- We visited 9 sites (e.g. Hubble, NIF, SNS, General Atomics, ESOC) to find out how other projects build control rooms and do remote operations.
- We completed construction of LHC@FNAL in February, and it is now being used for Tier-1 monitoring shifts and remote shifts for commissioning of the CMS silicon tracker.
- We have benefited from the CMS ROC group, which established a remote operations center in Wilson Hall (11th floor) in 2005 and participated in CMS remote shift activities (HCAL test beam, Magnet Test Cosmic Challenge Phases I & II) during 2006.
- We are developing software for the LHC controls system (LAFS Collaboration)
- We have an active group that is working on outreach.
- The goal is to have LHC@FNAL fully operational for commissioning with beam in 2008.

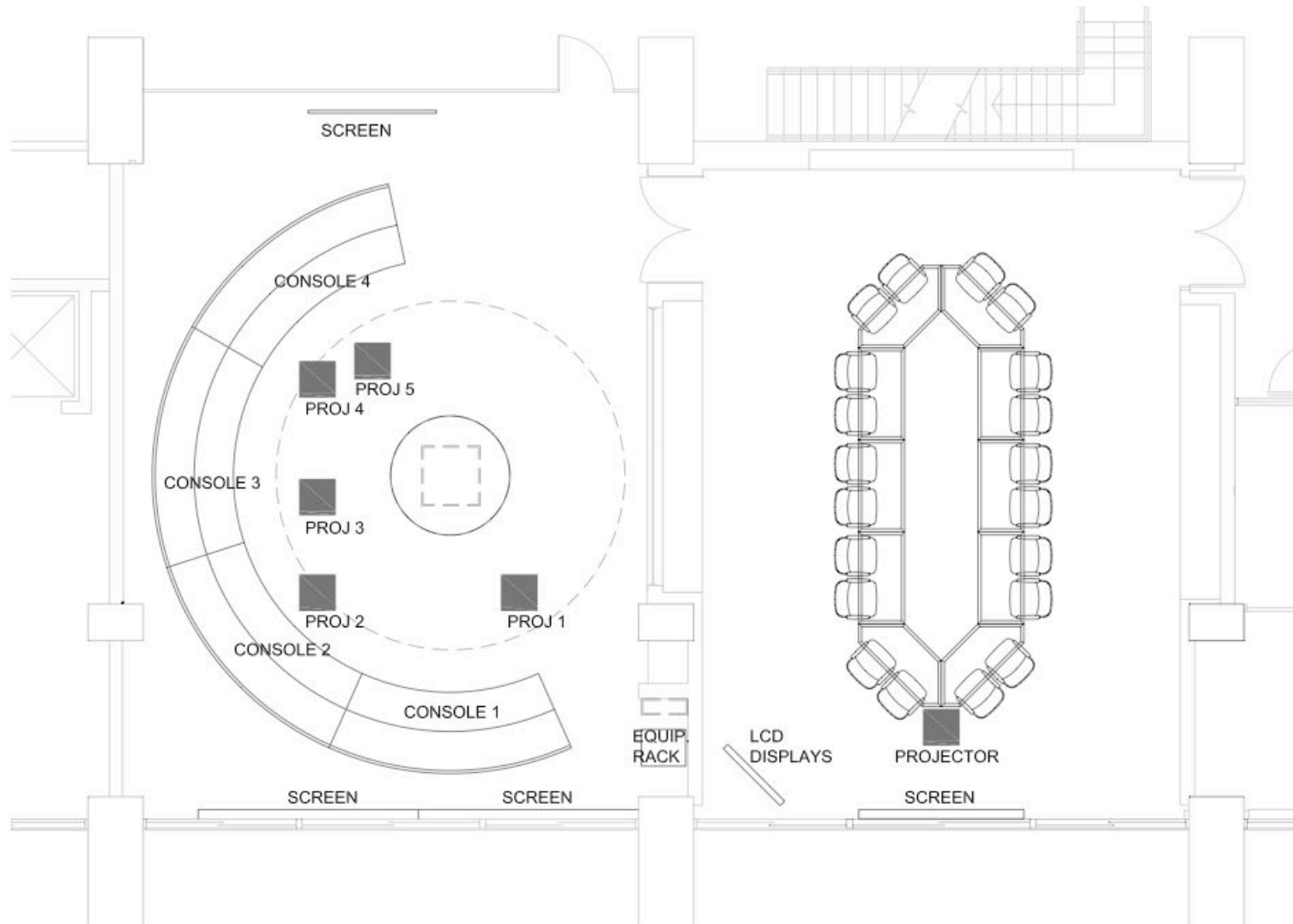
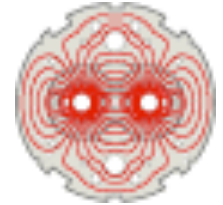


LHC@FNAL Location & Layout



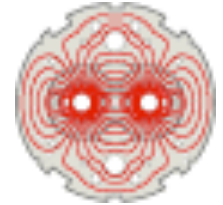


LHC@FNAL Layout





Noteworthy Features



Features that are currently available:

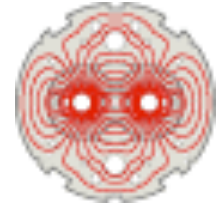
- CERN-style consoles with 8 workstations shared by CMS & LHC
- Videoconferencing installed for 2 consoles, can be expanded to 4 consoles
- Webcams for remote viewing of the ROC
- Secure keycard access to the ROC
- Secure network for console PCs (dedicated subnet, physical security, dedicated router with Access Control Lists to restrict access, only available in the ROC)
- 12-minute video essay displayed on the large “Public Display” used by docents from the Education Department to explain CMS and LHC to tour groups

Features under development:

- High Definition (HD) videoconferencing system for conference room
- HD viewing of the ROC, and HD display capabilities in the ROC
- Secure group login capability for consoles, with persistent console sessions
- Role Based Access Control (RBAC) for the LHC controls system (LAFS)
- Screen Snapshot Service (SSS) for CMS and the LHC controls system



Role Based Access Control (RBAC)



An approach to restrict system access to authorized users.

What is a ROLE?

- A role is a job function within an organization.
- Examples: LHC Operator, SPS Operator, RF Expert, PC Expert, Developer, ...
- A role is a set of access permissions for a device class/property group
- Roles are defined by the security policy
- A user may assume several roles

What is being ACCESSED?

- Physical devices (power converters, collimators, quadrupoles, etc.)
- Logical devices (emittance, state variable)

What type of ACCESS?

- Read: the value of a device once
- Monitor: the device continuously
- Write/set: the value of a device

Status:

- In development
- To be deployed at the end of June 2007

The software infrastructure for RBAC is crucial for remote operations in that it provides a safeguard. Permissions can be setup to allow experts outside the control room to read or monitor a device safely.

This is a FNAL/CERN collaboration (LAFS) working on RBAC for the LHC control system.



Screen Snapshot Service (SSS)



An approach to provide a snapshot of a graphical interface to remote users.

What is a snapshot?

- An image copy of a graphical user interface at a particular instance in time.
- Examples: DAQ system buffer display, operator control program, ...
- A view-only image, so there is no danger of accidental user input.
- Initially implemented for desktops, but could be targeted to application GUIs.

What is the role of the service?

- Receives and tracks the snapshots from the monitored applications.
- Caches the snapshots for short periods of time.
- Serves the snapshots to requesting applications/users.
- Prevents access from unauthorized applications/users.
- Acts as a gateway to private network applications for public network users.

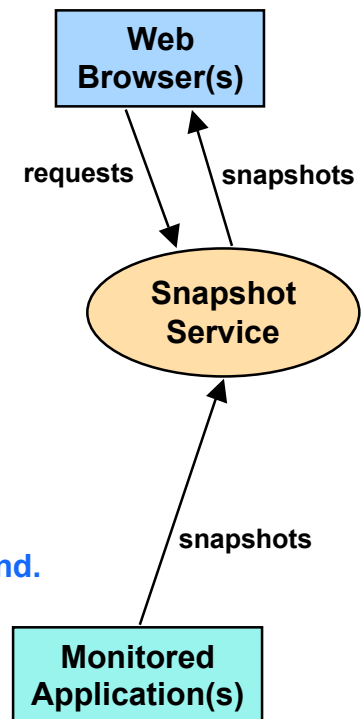
How does this work?

- Applications capture and send snapshots to the service provider in the background.
- Users would access snapshots using a web browser.

Status:

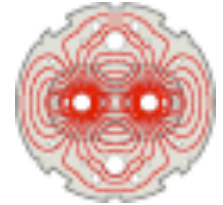
- SSS is being used by CDF for operations.
- SSS is being used by CMS Silicon Tracker Group, and is installed at CERN and in the ROC.

SSS is developed at FNAL for CMS. The LHC Controls Group is considering SSS for CCC.





Remote operations for LHC and LARP



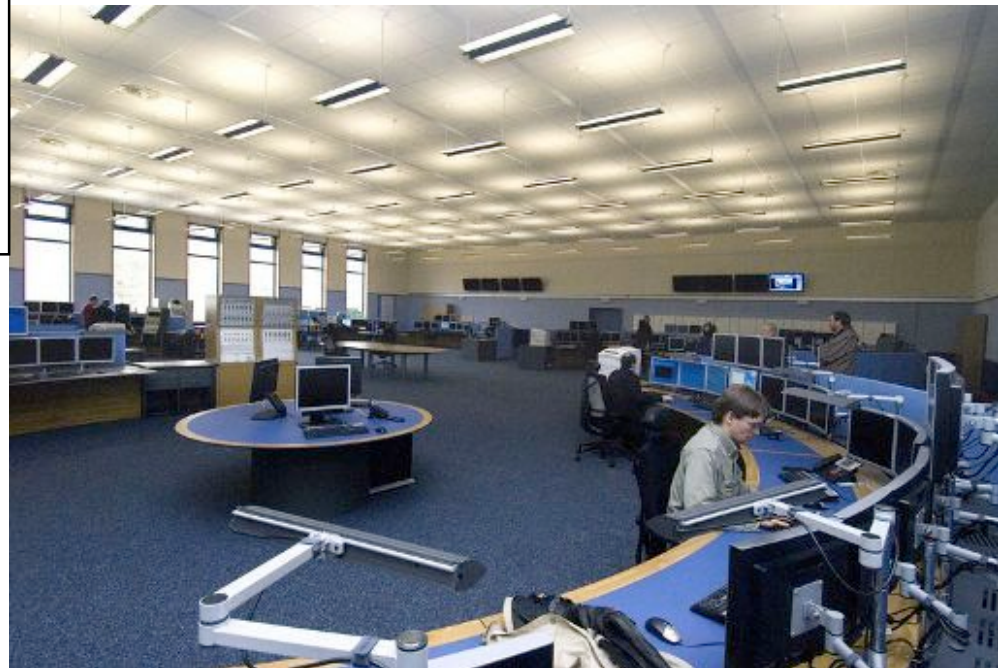
LHC remote operations:

- training prior to stays at CERN
- remote participation in studies
- 'service after the sale': to support accelerator components built in the U.S.
- access to monitoring information
- software development for LHC controls system (LAFS)

LARP: The US LHC Accelerator Research Program (LARP) consists of four US laboratories, BNL, FNAL, LBNL and SLAC, who collaborate with CERN on the LHC.

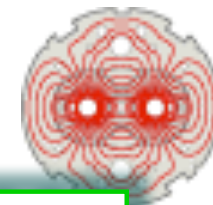
The LARP program enables U.S. accelerator specialists to take an active and important role in the LHC accelerator during its commissioning and operations, and to be a major collaborator in LHC performance upgrades.

CCC at CERN





CMS Control Room & Remote Operations Centers



2006

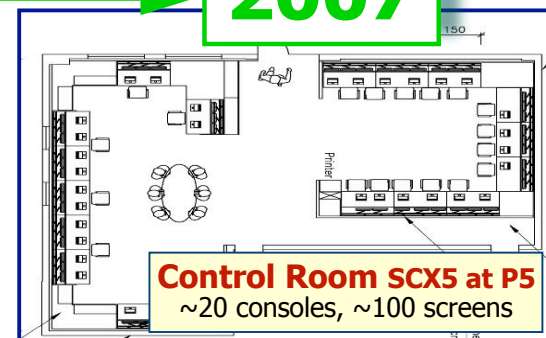
2007



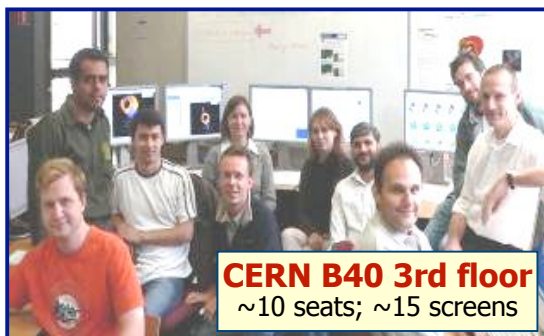
"Green Barrack" P5
~15 seats; ~20 screens

CMS Control Room

- CMS detector, trigger, DAQ
- Installation of the new control room is underway



Control Room SCX5 at P5
~20 consoles, ~100 screens



CERN B40 3rd floor
~10 seats; ~15 screens

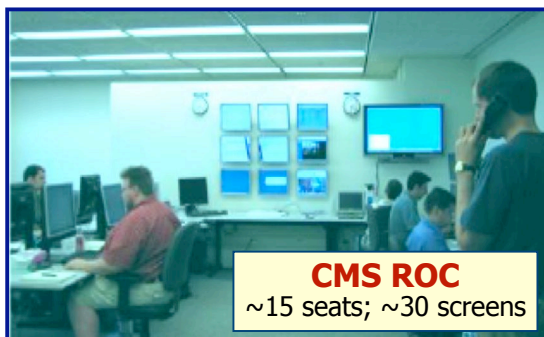
CMS Centre (Meyrin)

- Center-of-gravity for CMS Offline
 - DQM, calibration, express analysis
 - Offline computing operations
 - Communications with CMS Control Room and remote centers
- In former PS main control room



Significant refurbishment required

CMS Centre (Meyrin)
~25 consoles, ~150 screens



CMS ROC
~15 seats; ~30 screens

Remote Centers

- LHC@FNAL - possibly others in the future
- Share offline tasks with CMS Centre in Meyrin
- Tier-1, Tier-2 grid operations



LHC@FNAL
~10 consoles



Possible Assignment of Responsibilities



	CMS Control Room	CMS Centre & offsite remote centers
CMS sub-detector	<p><u>Responsibilities for sub-detector:</u></p> <ul style="list-style-type: none">• ensure safe operation of sub-detector and monitoring hardware• take calibration data• provide constants to the High Level Trigger (HLT)• check real-time data-quality monitoring for the sub-detector	<p><u>Responsibilities for typical sub-detector:</u></p> <ul style="list-style-type: none">• coordinate sub-detector offline operations• detailed sub-detector data-quality monitoring• liaise with counterpart in CMS Control Room• run dedicated jobs on express-line and calibration streams• provide updated constants for High Level Trigger (HLT) and Tier-0 processing of data
CMS global run / data-quality monitoring	<ul style="list-style-type: none">• monitor detector, trigger, and data acquisition status• monitor online data-quality monitoring results• communicate issues of data quality to other shift personnel in the CMS Control Room• liaison with CMS Centre, for example to request further studies of specific problems	<ul style="list-style-type: none">• real-time monitoring of detector, trigger, and data acquisition status (“mirrored displays”)• monitor global data-quality monitoring results from offline processing of data• collate run-quality information from all detectors• coordinate preparation of good/bad run lists• coordinate (with computing operations) scheduling of Tier-0 bulk processing of events• check data quality after Tier-0 bulk processing• liaise with offsite remote centers and experts



Summary



Remote operations in high energy physics (HEP) is the next step, to enable collaborators to participate in operations from anywhere in the world. The goals are to have:

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Fermilab has built the LHC@FNAL Remote Operations Center, which is shared by scientists and engineers working on the LHC and CMS.

For the LHC it provides a means to participate remotely in LHC studies, access to monitoring information, a training facility, and supports the collaborative development of software for the LHC controls system.

For CMS it provides a location (in a U.S. time zone) for CMS remote commissioning and operations shifts, and Tier-1 grid monitoring shifts.